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(54) STONE GRADER APPARATUS

(71) I, NORMAN GEOFFREY JORDAN, a British subject of Ure Bank, Ripon HG4 1JE, Yorkshire, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to a stone grader apparatus for use in separating-out rubble, aggregate, slag, shale or any other mineral material including lumps or discrete particles, hereinafter referred to as "stone", into different ranges of size.

In quarries, it is usual to provide stone crushing plant in order to crush or grind down the quarry material, and then stone grader or screener plants are employed in order to separate-out the stone into different size ranges as required. In very large scale operations, the crushing apparatus and the screening apparatus can be of large size, and usually have to be assembled on site since they would be too large to be transported to the site in the fully assembled state. Such apparatuses are very useful in large scale, long run usage, but are not suitable to be moved from one site to another at short time intervals in view of the considerable time involved in dis-assembling the apparatus ready for transport, and the subsequent time involved in re-assembling the apparatus at a fresh site.

In order to provide flexibility of operation, it is known to provide mobile apparatus which can be readily transported from one site to another, either by being loaded on a trailer or being towed along the main highway. However, mobile apparatus have to be designed on the basis that they can be readily transported, without substantial dis-assembly, and can meet traffic regulations in regard to size for large loads. Thus, for example, a maximum height of sixteen foot is allowed for many bridges on main highways, and other bridges encountered have even lower clearances. Therefore, since the mobile apparatus must have its size dictated by the traffic regulations when it is in the transport mode, this inevitably provides certain limitations as to the size and capacity of the apparatus when in an operating mode on site.

According to the invention there is provided a stone grader apparatus for use in separating-out stone into different ranges of size, comprising a main supporting frame, a secondary frame supported by said main frame, screens supported by said secondary frame for screening the stone into different size ranges, and a conveyor for feeding stone to the screens, in which the secondary frame is adjustably supported by said main frame for movement between an operating position for the screens and a lower position in which the overall height of the apparatus is thereby reduced, suitable for transport of the apparatus.

Thus, the overall height of the apparatus can be reduced to permit convenient transport of the apparatus, but the apparatus can be readily converted for normal screening operations when it arrives on site by upward adjustment of the secondary frame and the screens carried thereby.

Conveniently, the apparatus is a mobile apparatus in the sense that it is a wheeled apparatus which can be readily towed, or transported on a trailer, from one site to another, in order to provide optimum usage of the apparatus. By enabling the height of the apparatus to be increased when screening operations are to be carried out, the apparatus can operate as efficiently as conventional screening static apparatus which have to be assembled on site as a very time consuming task and which do not have the advantage of easy transport since they are not readily converted to a transport condition, but require substantial dis-assembly of the apparatus. Conventional mobile screening apparatus do not have height adjustability, and therefore are restricted in their height in view of the height restrictions which are involved in the transport of large apparatus by road or rail. Further with the known mobile screening apparatus, the height restriction which is involved, in view of the transport requirement, reduces the capacity of the apparatus so that, where a large through-put with a considerable range of screening sizes is required, this

necessitates the provision of a further screening apparatus to operate in tandem with consequent substantial increase in capital outlay, and running costs.

Preferably, the secondary frame is adjustably supported by the main frame, in that it is pivotably connected thereto for movement about a horizontal axis. The horizontal axis may be provided by a shaft or shafts arranged near one end of the secondary frame, and a suitable raising and lowering apparatus may be provided at the opposite end of the secondary frame. One form of raising and lowering apparatus which may be employed comprises a hydraulic ram. Since the ram will be operated infrequently, and to reduce the capital cost, the ram may be hand operated. However, it should be understood that many other forms of raising and lowering apparatus may be employed including power driven pump and hydraulic ram arrangements, or screw jacks.

The screens which are employed in the apparatus may be of conventional type, that is to say screens which are readily positionable, and removable, from the apparatus in order to permit worn elements to be replaced.

A generally conventional overhead conveyor may be provided in the apparatus for the supply of stone to the screens, and this conveyor is coupled with the apparatus in such a way as to be moveable upwardly and downwardly with the secondary frame. To enable the overall height of the apparatus to be reduced still further, for the transport mode, the overhead conveyor may be so mounted in the apparatus that the height of the highest part of the conveyor, in the screening operating mode, can be reduced for the transport mode. To achieve this, the overhead conveyor may have a pivotal connection at one end to the main frame, and may be supported at an opposite end by a removeable or an adjustable support. Said support will be arranged at the end of the conveyor which, in use, constitutes the highest point of the conveyor in the screening mode, and the support is operated whereby the conveyor can pivot downwardly so as to reduce the height of the highest point of the conveyor. The support may comprise a strut pivotally connected both to the secondary frame and to the conveyor, the strut being removeable in order to permit downward pivoting of the conveyor until it comes to rest on a suitable abutment e.g. a portion of the housing enclosing the screens. Alternatively, the support may comprise a hydraulic ram which is extensible and retractable in order to vary the height of the associated end of the conveyor.

It should be evident that a stone grader apparatus according to the invention may be constructed to have any desired overall working height in a screening mode, provided that the secondary frame with the screens carried thereby is able to be downwardly adjusted relative to the main frame so as to reduce the overall height of the apparatus to a height compatible with transport of the apparatus on the highway, or by rail if rail transport is envisaged. Furthermore, by enabling the overall height of the apparatus to be reduced, the volume of crating required to contain the apparatus can be considerably reduced as compared with crating required to contain a conventional screening apparatus having the same height as that of the apparatus according to the invention in the screening mode. A reduction in size in crating can reduce significantly the shipping costs which are based on volume.

In view of the possibility of a substantial overall height of the apparatus in the operating mode, it is preferred that the screens are provided in order to enable separating-out of stone into three or more different size ranges. A conventional discharge conveyor may be arranged below the screens in order to convey "fines" which pass straight through the screens. The fines conveyor may project from the apparatus in the operating mode, in order to discharge the fines, but the projecting end portion of the conveyor may have two spaced pivot regions each providing a horizontal pivot axis and enabling the end portion of the fines conveyor to be folded up for the transport mode of the apparatus.

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:—

Figure 1 is a side view of a centre portion of one embodiment of stone grader apparatus according to the invention having a main frame, and a secondary frame supported by the main frame and carrying screens;

Figure 2 is a side view of a hopper provided at a stone supply end of the apparatus; and

Figure 3 is a side view of the discharge end of a "fines" conveyor provided at the opposite end of the apparatus; and

Figure 4 is a side view of a further embodiment of stone grader apparatus according to the invention.

Referring now to Figure 1 of the drawings, there is shown a centre portion of a mobile stone grader or screening apparatus designated generally by reference numeral 10. The apparatus comprises a main box frame 11 comprising two longitudinal steel beams interconnected by lateral beams. The main frame 11 is supported by wheels (shown diagrammatically in Figures 1 to 3) to facilitate transport of the apparatus either as a towed trailer or on a low loader. A secondary frame 12 is adjustably supported

by the main frame 11, the secondary frame carrying or supporting a set of screens in the volume defined above the secondary frame 12 bearing the reference numerals 13. The screens are not shown in detail in the drawings, and may be of generally conventional construction in order to carry out separating out of the stone into required size ranges. As illustrated purely by way of example, the screens provide for separation into two size ranges, in addition to the separation out of "fines" present in the stone supplied to the apparatus.

The secondary frame 12 is adjustably supported by the main frame 1 1so as to cnablc the overall height of the apparatus to be adjusted and, to this end, secondary frame 12 is connected to main frame 11 at one end of the secondary frame 12 for pivotal movement about a substantially horizontal axis. This horizontal axis is provided by a pair of stub shafts or a continuous shaft indicated by reference numeral 14. The end of the secondary frame 12 remote from the pivotal connection is supported by a support in the form of a hydraulic ram 15. The ram 15 is supported by the main frame 11 and has a pivotal connection 16 provided at the end of a rod 17 of the ram, and which engages the forward end 18 of the secondary frame 12. Evidently, adjustment of the ram 15 will cause pivotal adjustment of the secondary frame 12 about its horizontal pivotal axis, whereby the overall height of the apparatus can be adjusted. The screens 13 are carried by the secondary frame 12, and are therefore pivotal upwardly and downwardly therewith. Furthermore, a portion 19 of an overhead conveyor for supplying stone to the screens is arranged in the apparatus so as to have its highest point, in the screening mode, adjustable as to height consequentially upon the pivotal adjustment of secondary frame 12. To this end, conveyor portion 19 is pivotally connected at 20 to an upright portion of the main frame 11, and the opposite end 21 (Fig. 3) of the conveyor portion 19 is supported from the secondary frame 12 by one or more supports. By way of example only, in Figures 1 and 3 there is shown one support in the form of a removable strut 22 which is pivotally connected at one end to the secondary frame 12, and at the other end to the conveyor portion 19. A second strut takes the form of a hydraulic ram 23 which also is pivotally interconnected between the secondary frame 12 and the conveyor portion 19. Strut 22 is intended to be disconnected or removed in order to permit lowering of the end 21 of conveyor portion 19, in which case the conveyor portion 19 will pivot downwardly until it comes to rest on a suitable abutment e.g. a portion of a housing for the screens 13. The ram 23 may be lengthened or shortened in order to vary the height of the end 21, or may be employed solely to raise the conveyor portion 19, and hold the conveyor portion 19 until such time as the strut 22 can be reconnected or replaced in order to provide a permanent support.

The secondary frame 12 comprises a rectangular assembly of I beams, and is so arranged that it can pivot between an upper working position, as shown, to a lower transport position without obstruction by the main frame 11 or any rigid support carried by the main frame 11.

The conveyor portion 19 forms a part of a conveyor for supplying stone to the screens 13, and further parts of the supply arrangement are shown in Figure 2. A hopper 24 is arranged at the right end of the main frame 11, and stone, rubble, aggregate and the like is discharged into hopper 24 by any suitable means e.g. tipping from a lorry, conveyor belt supply, or direct supply from stone crushing apparatus operating in tandem with the illustrated stone grader apparatus to form a complete stone processing plant.

A conveyor 25 is supported rigidly by the main frame 11 and arranged to receive stone discharged through the bottom of hopper 24, and to convey such stone to the left as seen in Figure 2, to supply the stone to the conveyor portion 19. It will be evident from Figures 1 and 2 that conveyor 25 is provided with guide boards 26 to prevent spillage of stone over the sides of the conveyor 25, but such boarding is not required for conveyor 19 since any spillage will only fall onto the screens 13. However, the majority of the stones carried by conveyor portion 19 are raised towards the left in Figure 1 to a stones fall onto the set of screens 13 where they undergo grading or separating-out into the required different size ranges.

In Figures 3 of the drawings, there is shown the discharge end of a "fines" conveyor 27 which is supported by, and extends below, secondary frame 12, as seen in Figures 1 and 3, and projects outwardly of the main body of the apparatus in order to discharge fines at a discharge location. The conveyor 27 also is pivotable upwardly and downwardly with secondary frame 12 about pivot 14. The fines conveyor 27 extends substantially wholly below the screens 13 in order to catch "fines" which pass straight through the screens to fall onto the fines conveyor 27, where they are moved upwardly and to the left as seen in Figures 1 and 3 for discharge purposes. The projecting end part 28 of the fines conveyor 27 is shown in a normal operating mode, but it can be folded so as to reduce the overall length of the apparatus for the transport mode thereof. To this end, a pair of spaced hinge or pivot connections 29 and 30 are

provided, each connection providing a horizontal pivot axis and connection 30 permitting clock-wise pivoting of the end 28, and connection 29 permitting anti-clockwise pivoting of the part of conveyor 27 projecting to the left of connection 20. Thus, the projecting part 28 of the fines conveyor can be folded up in concertina manner in order to reduce the extent by which it projects from the main body of the apparatus. A pivotally connected tie rod 31 normally holds the projecting part 28 of the fines conveyor 27 in the operating mode.

It is preferred that the drive to the various conveyors and a drive to impart movement to the screens are in the form of electric motor drives with belts and pulleys, and these are generally of standard arrangement and will not be described in detail. However, it should be understood that many other of the types of drive systems conventionally employed in stone grader apparatus may be used instead of electric motor drive systems.

With regard to the screens designated generally by reference numeral 13, these may take any convenient form and arrangement, but in the illustrated arrangement there is provided a so-called two deck screen. This provides for separation of stone into three ranges of sizes, with the largest size being separated out at the top of the screens and passing to a discharge chute 32 (Fig. 2) having an outlet 33 at one side of the apparatus from which the largest size fraction of the stones are discharged onto a conveyor 34. The next largest size is separated-out in the screens 13 and is discharged via chute 35 to an outlet 36 on the side of the apparatus opposite to the outlet 33. The fraction from outlet 36 also falls onto a respective conveyor 37. Finally, the smallest fraction size comprises those particles which pass straight through the screens 13 and fall onto the fines conveyor 27. A guide chute or tail gate 38 is provided adjacent the lower right-hand end of the screens 13 in order to collect and discharge fines onto the conveyor 27.

While the illustrated arrangement provides separation-out of stones into three size ranges, it is to be understood that the apparatus may incorporate screening so arranged as to effect separation-out into any one or more size range as desired. Thus, the illustrated arrangement could readily accommodate a further screening arrangement, whereby four size ranges could be obtained, in which case an appropriate discharge arrangement will be provided in order to effect discharge of material in a size range intermediate the "fines" and the size of the material discharged through outlet 36.

An alternative embodiment is illustrated in Figure 4, and is of generally similar construction, so that corresponding parts are designated by the same reference numerals and will not be described in detail again. In this embodiment, a four deck screen 13*a* is provided, which separates-out stone into four size ranges in addition to "fines". The discharge outlets for the decks are shown at 39, 40, 41 and 42 in Figure 4. As in the previous embodiment, both the screen 13*a* and the fines conveyor 27 are pivotable upwardly and downwardly with the secondary frame 12 about pivot 14, and the lower transport position of the screen is shown in dashed lines in Figure 4.

The portion 19 of the feed conveyor is pivotable about pivot 20 as in the previous embodiment, but the hydraulic ram is dispensed with since the support for the end 21 enables the portion 19 to move about pivot 20 simultaneously with the movement of secondary frame 12 and to the conveyor end, strut 42 is pivoted at each end to the secon dary frame 12 and to the conveyor portion 19, and the geometry of the arrangement is such that the end 21 has a greater rate of descent than the uppermost end of the screen. This is possible in that the conveyor portion 19 can fit between and descend below, side plates (not shown) at the top of screen 13*a* so as to rest on the top of the screens in the transport mode.

The stone grader apparatus shown in Figures 1 to 3, and Figure 4, are mobile apparatus, and wheels therefor are designated diagrammatically by reference numeral 43. However, it should be understood that the feature of providing a main frame, and a secondary frame carrying screens and adjustably supported by the main frame to permit adjustment in the overall height of the apparatus may equally be applied to a non-mobile or fixed installation, so that this invention is not restricted to mobile stone grader apparatus. Although fixed installations are, evidently, not intended for frequent movement from one site to another, nevertheless the ability to reduce the overall height of a fixed installation would be advantageous as regards the transport thereof. Furthermore, crating costs for a fixed installation also would be substantially reduced in similar manner as for a mobile apparatus.

By way of example, the principle of providing a pivoting frame (secondary frame) carrying a screen deck may be embodied in a crushing apparatus to form a composite apparatus. This is particularly advantageous in so-called secondary crushing and screening units which usually are provided with (a) screening units which are of such a size that they must be manufactured separately, and then are assembled (and dis-assembled) on site or (b) screening units which form part of the apparatus as manufactured, but

which are necessarily of small size to avoid problems of transportation.

By providing a stone grader apparatus according to the invention in a stone crusher apparatus, it is possible to provide a composite apparatus having a large stone grading capacity, and yet which can be readily transported following conversion of the stone grader apparatus to a transport mode i.e. by reducing the height thereof.

WHAT I CLAIM IS:—

1. A stone grader apparatus for use in separating-out stone into different ranges of size, comprising a main supporting frame, a secondary frame supported by said main frame, screens supported by said secondary frame for screening the stone into different size ranges, and a conveyor for feeding stone to the screens, in which the secondary frame is adjustably supported by said main frame for movement between an operating position for the screens and a lower position in which the overall height of the apparatus is thereby reduced, suitable for transport of the apparatus.

2. Apparatus according to claim 1, in which the secondary frame is pivotally mounted on said main frame.

3. Apparatus according to claim 2, in which the secondary frame is mounted on a pivot at a lower end of the secondary frame.

4. Apparatus according to any one of claims 1 to 3, including a "fines" conveyor arranged below the screens, in which the fines conveyor is supported by the secondary frame for movement therewith.

5. Apparatus according to any one of claims 1 to 4, in which the conveyor has a conveyor portion extending above the screens, said conveyor portion being pivotally mounted at one end on the main frame and being supported at or near the opposite end by the secondary frame.

6. Apparatus according to claim 5, including an adjustable support interconnecting said conveyor portion and the secondary frame.

7. Apparatus according to claim 5 when appended to claim 2, including a strut pivotally connected between the conveyor portion and the secondary frame whereby the conveyor portion is pivotable with respect to its pivotal mounting on the main frame in response to pivotal adjustment of the secondary frame.

8. Apparatus according to claim 4 or any one of claims 5 to 7 when appended to claim 4, in which the fines conveyor has a discharge end which projects from the apparatus, said discharge end being collapsible about spaced pivots in order to reduce the length thereof.

9. Apparatus according to any one of the preceding claims, including a ram connected between the main frame and the secondary frame and operable to effect adjustment movement of the latter.

10. Apparatus according to any one of the preceding claims, including a hopper mounted on the main frame and arranged to discharge stone onto the conveyor.

11. Apparatus according to any one of the preceding claims, in which the screens are constituted by a multideck screen.

12. Apparatus according to any one of the preceding claims, in which the apparatus part of a stone crushing apparatus.

13. Apparatus according to any one of the preecding claims, in which the apparatus is welded apparatus.

14. A stone grader apparatus substantially as hereinbefore described with reference to, and as shown in Figures 1 to 3 of the accompanying drawings.

15. A stone grader apparatus substantially as hereinbefore described with reference to, and as shown in Figure 4 of the accompanying drawings.

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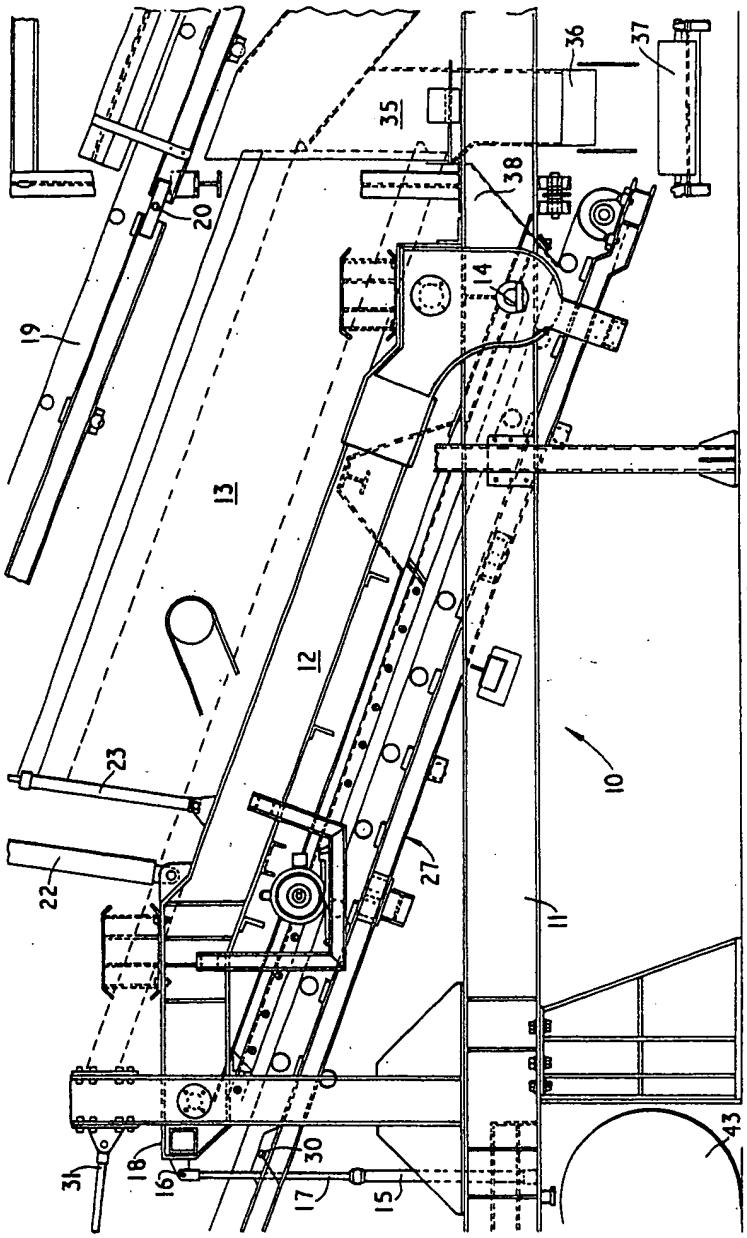

FIG.1.

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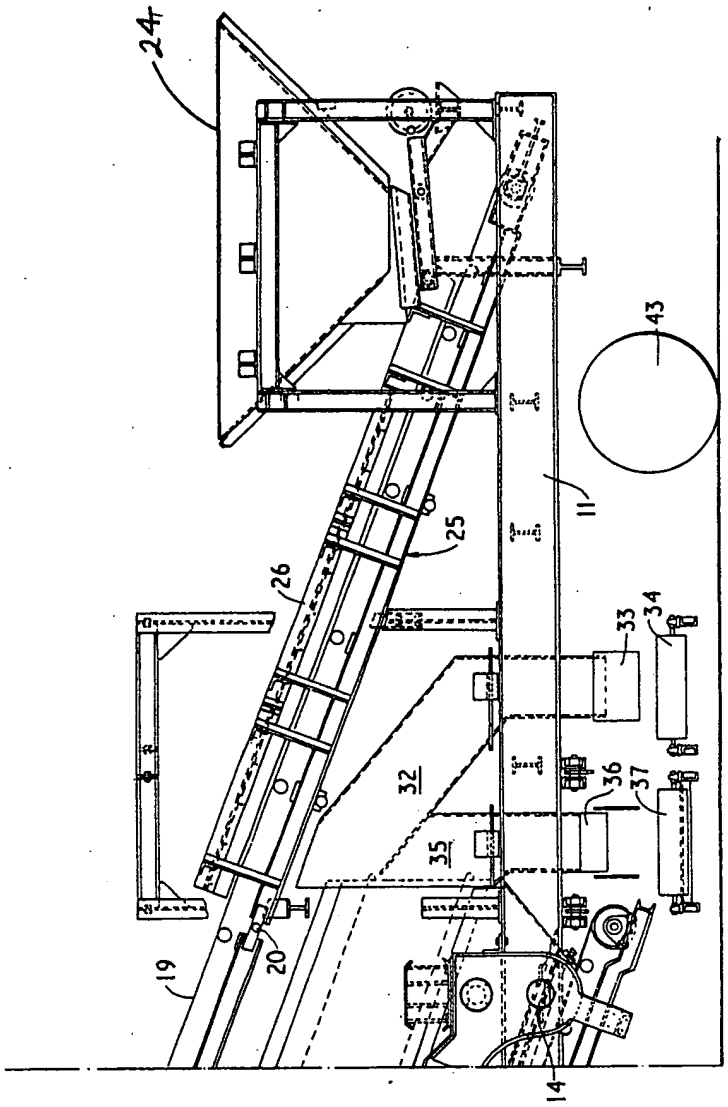

FIG.2.

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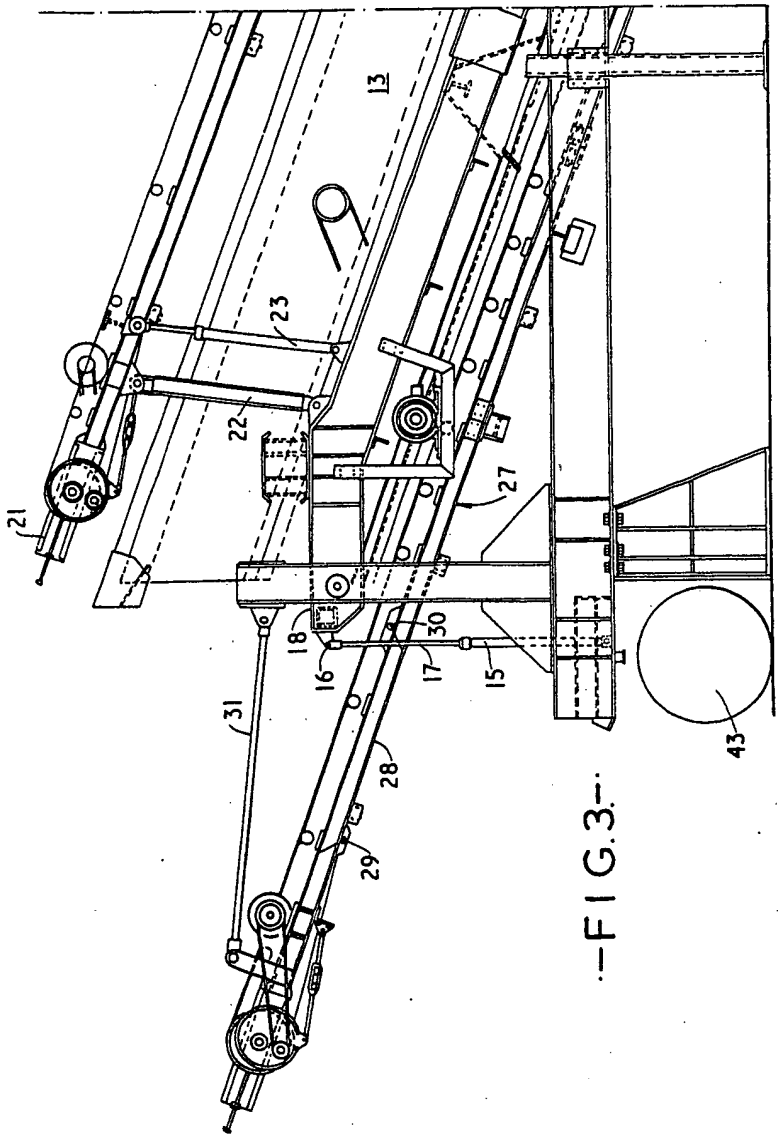

FIG.3.

1553667 COMPLETE SPECIFICATION

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Sheet 4

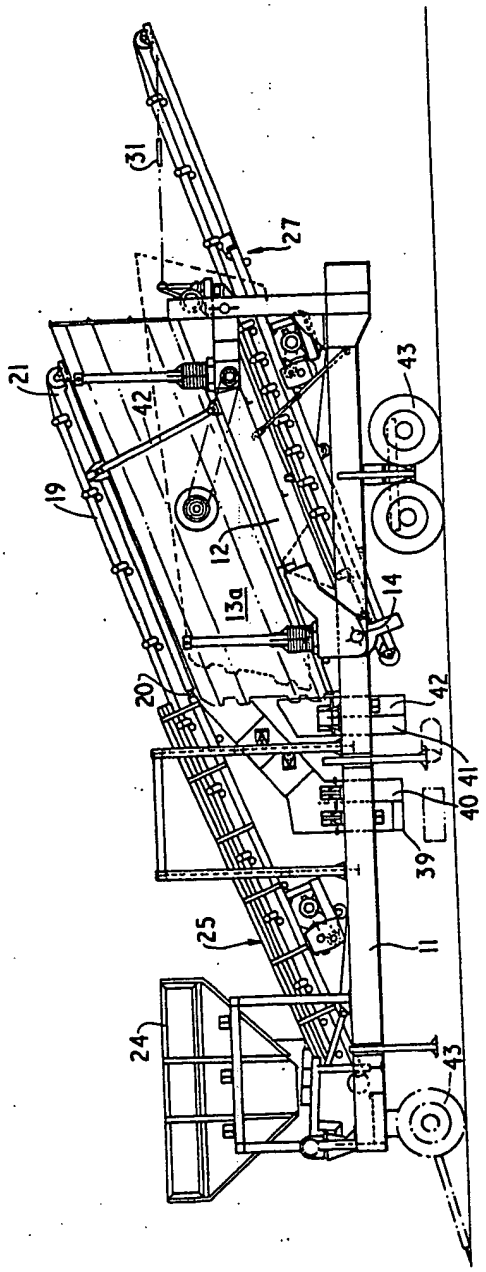

FIG.4.